

National Security Space Policy in the U.S. and Europe

Trends and Choices

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On the 22nd and 23rd of April, 2002, a conference on “space and security” was held at the Massachusetts Institute of Technology Faculty Club in Cambridge, Massachusetts.

This conference was co-organized by the MIT Security Studies Program and the MIT-France program under the leadership of the Mission for Science and Technology of the French Embassy in the USA. The purpose of the event was to gather government, industry and academia to discuss the current security applications of space, both in the USA and in France, and opportunities to leverage space to increase international security through transatlantic cooperation.

The rich and open discussions at the sessions were strong indicators of the conference’s success and timeliness. So too was the participation of very well qualified speakers, including both the Ambassador of France and Dr. James Roche, Secretary of the U.S. Air Force.

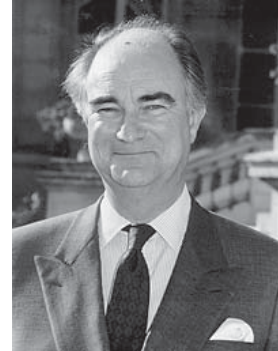
We are honored to provide you with the final report, which summarizes realistically and objectively the outcome of this original meeting in Cambridge. We believe more work is necessary in this strategic domain, and we invite our potential counterparts to take the lead in ensuring the continuity of this initiative, perhaps in Europe.

Following the Welcoming Address of Ambassador François Bujon de l’Estang is the conference report, prepared by Assistant Professor Eugene Gholz.

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Ambassador's Address

Remarks by His Excellency François Bujon de l'Etang
at the "Space and Security" Conference
MIT Faculty Club
April 22, 2002



Ladies and gentlemen,

I would like first of all to thank MIT for hosting this seminar on the timely topic of "space and security." My gratitude goes to Dr. James Roche, the Secretary of the Air Force, who agreed to be the featured speaker this evening, and to Professor Sapolsky, director for security studies here at MIT, for organizing this challenging event with great dedication and efficiency.

I am also pleased that a number of industrial partners joined ranks to help make this seminar possible. I want to express my appreciation to Alcatel, Arianespace, the Boeing Company, EADS, Lockheed Martin and Snecma for their active participation.

It is a pleasure to be here once again at MIT, one of the most prestigious universities in the world. With more than 900 professors and some 10,000 students, MIT draws its strength from its excellence in science and technology—the fact that 11 Nobel prizes were awarded to MIT professors is particularly telling—from inter-disciplinary and international cultures, and last but not least, from the special relationships it maintains with both the government — the Lincoln Lab in particular is represented here today—and industry. In this context, today's event has been made possible thanks to a program called MIT-France. As you may know, France recently decided to launch a bilateral program to promote exchanges of professors, researchers, and interns between French universities, labs, industries and MIT. MIT-France is therefore the direct result of a mutual and consensual interest.

Taking advantage of all the above, the "space and security" seminar has attracted an impressive, diverse and international audience. It is an honor and a privilege to address such a prestigious group on such a strategic topic. The issues you are addressing today are of the utmost importance as their implications are considerable.

This seminar was initially planned for October 2001. September 11 pushed it back. That was for the best. Meanwhile, as the war against terrorism was going on, the United States once again demonstrated to the world the tremendous tactical and strategic advantages of space assets. Collecting all sorts of data around the globe, at any time, in

any weather, transporting such data, generating information, disseminating knowledge to local populations, connecting people, targeting, planning, guiding and tracking are among the best known functions of space assets.

But that isn't all. Space, as expressed in the [Joint Vision for 2020](#) is the additional dimension that enhances force and allows for network-centric warfare. It is indeed the center of the two principles of the military strategy defined by Von Manstein, realism and force concentration or "schwerpunkt." It isn't surprising that the Rumsfeld report noted that space is as strategic today as nuclear deterrence was during the cold war. But you are the experts and have already discussed these points in detail this morning. So let me focus on three elements at the core of this seminar: the position of the European Union, the need for transatlantic cooperation and the role of France in this cooperation.

The European Union's Position

Although perhaps not quite ripe today, the use of space for civil security and environmental monitoring has a promising future. Europe is more advanced in these applications, known as "useful space." You have heard about that this morning as well. The current genesis of the GMES program and the existence of the operational charter of the management of industrial and natural disasters tend to prove this point.

Applied to civil or military security, space assets rely on the same dual-use technologies. Europe has developed most of them through civilian channels. From launchers to remote sensing, from optics to radar, from visible wavelengths to infra-red and hyper spectrum, from space telecommunication to space exploration, Europe created the know-how, managed the resources and shaped the talents to become a prime space power. This was made possible thanks to the European Space Agency, ESA, and such national space agencies as the CNES, the French Space Agency, which celebrated its 40th anniversary last December. As you all know, however, Europe is still a work in progress. That progress is rapid and visible. After the formation of the European Economic Union, based on free trade, and after the advent of the Euro, the common currency emblematic of European financial unity, Europe is working toward common security and defense.

A European defense will take into account the new environment of the 21st century. It will also take advantage of new technologies. Such a defense will be irreversibly flawed without the appropriate space capabilities. Again, most of these technologies are available within Europe. There is no doubt in my mind that Europe will not miss this tremendous and historic opportunity. Europe will rise to the challenge of "transforming" our defense policy, our defense strategy and our defense capabilities. It might take some time — five, even ten years — but Europe will be there.

The recent decision on Galileo, the European satellite navigation system — clearly a dual-use space system — supports this last point. The Galileo decision is a very significant one. Galileo is the first European space program to be decided on and funded by the European Union. Therefore, it represents a major step in European integration, a step that only a few months ago many thought would be impossible. And finally, Galileo offers an easy transition to the second element I wanted to mention . . .

The Need for Transatlantic Cooperation

There is no denying that there are some impediments to transatlantic cooperation on space for security, such as transatlantic industrial competition and the quest for autonomy. However, I see three main driving forces for transatlantic cooperation in this strategic field: cooperation will be operational, it will allow for real burden-sharing, and it will have a commercial dimension.

First, I believe it is quite realistic to state that Europe and the United States are allies and will remain allies. Europe and the United States share the same values — universal values like freedom and democracy — and the same threats — global threats as specific as terrorism or global warming — and since the end of the cold war they have fought shoulder to shoulder on several occasions. Second, space is global and expensive. It makes perfect sense, between allies, when appropriate, to develop, build and operate common space infrastructures. The best example to date, although still in the pre-development phase, is the “NPOESS” program: the new polar orbiting environment satellite system. It will be built around two American satellites and one European satellite, METOP, from the European meteorology organization EUMETSAT. It will serve both military and civilian needs, European and American. However, each partner might want to preserve its independence for the sake of its own national security. When that applies, different systems will be necessary. These different systems must be interoperable in order to be used simultaneously. The different systems must in fact have only positive effects on each other’s performances. Then, combined as a system of systems, they will provide superior performance and integrity. That is certainly the case for Galileo/GPS. Finally, some of these space systems are dual-use. While they may be military, they are very likely to evolve toward civilian applications.

Again, space being global, there is no sense in developing local standards that would act as trade barriers and would prevent the development of a global market. Here again, the GPS/Galileo example is striking, as is the example of Ariane 5, which was designed to space-shuttle standards, the benchmark in civil, commercial and military space transportation during the 80’s. One must acknowledge that sharing a standard, which I believe is the lowest form of cooperation, requires a minimum level of exchange. This is important and relates directly to a point that you cannot leave out during this seminar, the U.S. control of exports of sensitive technologies. The United States has the leadership in most of the military space systems and there is no denying that it sets the standards. But what happens when the standard is not shared? Another standard will emerge to further reinforce walls and fortresses.

The Role of France in this Cooperation

France has always valued space as a strategic domain. On the one hand, it has always been the main contributor to the European space agency and the leading European country in space in terms of its budget, technology and industrial capability. On the other hand, it has enjoyed long-standing cooperation in space with the U.S. CNES has worked in civil space with both NASA and NOAA for more than 30 years. Their cooperation has always been very efficient, fruitful and safe. Over the past decade it has grown in both quantity and quality. Today there are more than 30 ongoing

bilateral space projects between our two countries. Keeping all that in mind, I believe France has a key role to play in fostering this transatlantic cooperation in space for security on earth now and for the future.

For the future we must act now. Education is essential. MIT-France could be instrumental in promoting American and French students to study, research and dream together about space.

Thank you for your support. I wish you an excellent seminar.

National Security Space Policy in the U.S. and Europe

Trends and Choices

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October 2002

Executive Summary

Since the end of the Cold War, the availability of new technologies and changes in the national security environment have raised the possibility of substantial new demand for military space systems. Trends in technology, military operations, politics, and economics highlight several possible trajectories for national security space policy. Decision-makers in the United States and in Europe are preparing today to make key choices about military doctrine, resource investments, and the policy goals that leaders hope to achieve using military operations that rely on space assets.

The wish-list for new space systems includes improved intelligence-gathering satellites, navigation satellites to enable precision strike against fixed and mobile targets, and communications satellites to allow decentralized forces to share access to information

and coordinate operations in a complex environment.

Both the U.S. and European governments may find it useful to cooperate on national security space policy. Forming coalitions for military action should have substantial political and financial benefits, but recent attempts at cooperative operations have been hampered by the failure to coordinate equipment investments in the past. In addition to the well-publicized lack of communications interoperability, coalition forces also discovered that they had a surplus of



some types of equipment while other ‘low density, high demand’ systems were unavailable.”

The economic needs of the space industry also play an important role in the future trajectory of national security space policy. Space systems contractors are losing money in the wake of their fixed investment in capacity in the expansive 1990s. Trans-Atlantic coordination among government buyers might reduce the risk of future overcapacity, if coordination helps to eliminate redundancy among programs.

Major national security investments, including those for space, require the convergence of four key factors: technical capabilities, military operational requirements, domestic and international political support, and adequate economic resources. The key technological change affecting national security space is the rapid increase in computer processing power. Faster computers can derive extra information from sensing data. But as tantalizing as the advances in information gathering and dissemination are, some important constraints are not likely to be overcome in the near term. Consequently, the full vision of a space-based information technology revolution in military affairs will not arrive imminently. Moreover, the differences between the American and European militaries’ visions of future operations are likely to lead to different levels and types of investment in national security space systems. Those differences raise barriers to trans-Atlantic co-development of new space assets.

The most important trend affecting trans-Atlantic plans for military space is the growing prevalence of coalition operations. The expectation that militaries will work together during future operations may bring about a “harmonization up” of requirements for investment in space, but the prospect of acting through coalitions might instead limit the ability of the United States to integrate space-based assets into routine military operations as fully as it would like.

Finally, overcapacity in the space industry tends to persist, and is costly too. The current acute overcapacity crisis could significantly raise the cost of “transformational” space investment — perhaps to a prohibitive level, especially for European countries.

The United States and Europe have generally compatible foreign policy interests that sometimes diverge in specific cases, and they have generally compatible approaches to defense acquisition that also sometimes diverge. If policy-makers decide that they place a high value on tight integration and interoperability of coalition military operations, they will have to make certain decisions about budgets and military doctrine subservient to that goal — a substantial cost to weigh against the benefits of cooperation. It is more likely that policy-makers on both sides of the Atlantic will independently recognize the opportunities afforded by investment in the military use of space, and each country will independently pursue its own agenda in that area.



..... *Delta III
launch*

The Dawn of a New Space Age

Many times during the twentieth century, innovations in the use of space transformed the national security environment and forced policy to adapt. Substantial Cold War investment in military space research yielded a broad array of systems that shaped the American and European forces, improving strategic intelligence gathering, establishing command and control on a truly global basis, and offering the possibility for long-range weapons targeting. Space systems underpinned a change in the emphasis of the American way of war away from the “arsenal of democracy” that would win by out-producing enemies to a technology-intensive force that would win through sophistication. Innovative organizations for space systems engineering and integration emerged to manage investment in space, and those techniques spread throughout the national security establishment as a dedicated defense industry evolved to supply the military’s technology-intensive needs.¹ The shift in national strategy, military doctrine, and scientific and industrial support had indirect effects on European militaries through NATO coordination, but it did not drive as much military space investment in Europe as in the United States. Yet the net effect of the West’s technological investment played a major role in convincing the Soviet government that it could not keep up the strategic competition. The result contributed to the peaceful resolution of the Cold War.²

Since the end of the Cold War, the availability of new technologies and changes in the national security environment have raised the possibility of substantial new demand for military space systems – again, the prospect for a new space age. The massive increase in available computer processing power has triggered discussions of an information technology-based Revolution in Military Affairs (RMA), and the American military services have each started down paths of “transformation” to take advantage of the RMA. New space systems are central to the transformed force, providing data from intelligence-gathering satellites, advanced capabilities for maneuver and precision strike against fixed and mobile targets, and new operational concepts based on decentralized forces that can act together in a complex environment using communications satellites to share access to information. If transformation is to be pursued to its logical conclusion, existing assets will have to be augmented and / or replaced by specially designed systems that capitalize on the new information technology.³ Moreover, the elevated demand for intelligence preparation of the battle space and real-time battle space awareness during military operations calls not only for new system designs, but also for a greater investment of resources simply to expand the number of space-based assets.

Meanwhile, changes in the threat environment also augment the prospects

for investment in new space systems. The end of the Cold War has changed military planning from its focus on the Soviet Union, which primarily tasked space assets with strategic missions, to planning for regional contingencies and so-called operations other than war.⁴ The new focus requires creative use of space assets for theater-level tasks, including real-time operational and tactical intelligence, battle-damage assessment, and dense communications in areas of the world that have not

plans to use UAVs in a wide range of missions that would otherwise endanger pilots, but communications with UAVs consume a tremendous amount of bandwidth. For now, satellites provide the vast majority of that bandwidth for all but the most tactical UAVs. Although in the long run other UAVs used as communications relays may take up some of the burden, the pressure for friendly forces to stand off further from dangerous objective areas will support at least some additional reliance on space.

A U.S. military estimate from December 2001 predicts that American warfighters will demand satellite communications capacity on the order of 17 gigabits per second by 2010 — up from less than 2 Gbps on station in 2002.⁵

Other changes in the international security environment have more ambiguous implications for the amount of investment in space systems. During the 1990s, almost all of the theater and humanitarian military operations that involved forces from the U.S. and Europe were coalition operations. Working closely with allies provides political cover and shares the expense of military action, but actual operations have often been hampered by a lack of coordination of past equipment investments. Allied forces could not rely on the interoperability of systems — their physical ability to exchange data and work together in force packages — especially in circumstances that stressed the need for secure and/or real-time connections. Coalition forces also discovered that they had a surplus of certain types of equipment, created by redundant acquisition programming, while availability of other “low density, high demand” systems was constrained because coalition members had neglected to



*Post-strike image
of transformer site
in Serbia*

been extensively prepared with peacetime investment in terrestrial technologies. Existing systems have performed surprisingly well in the new environment, but systems designed with the new missions in mind should perform even better.

Additionally, the widespread acknowledgment in post-Cold War era of major powers’ intense desire to avoid casualties will drive investment in space. Because of the successful deployments of Predator and Global Hawk in Afghanistan, unmanned aerial vehicles (UAVs) have been universally cited as “transformational” systems. In the future, the military

coordinate and rationalize their specialized investments. Trans-Atlantic coalition problems were particularly acute in the space-related areas of intelligence and communications.

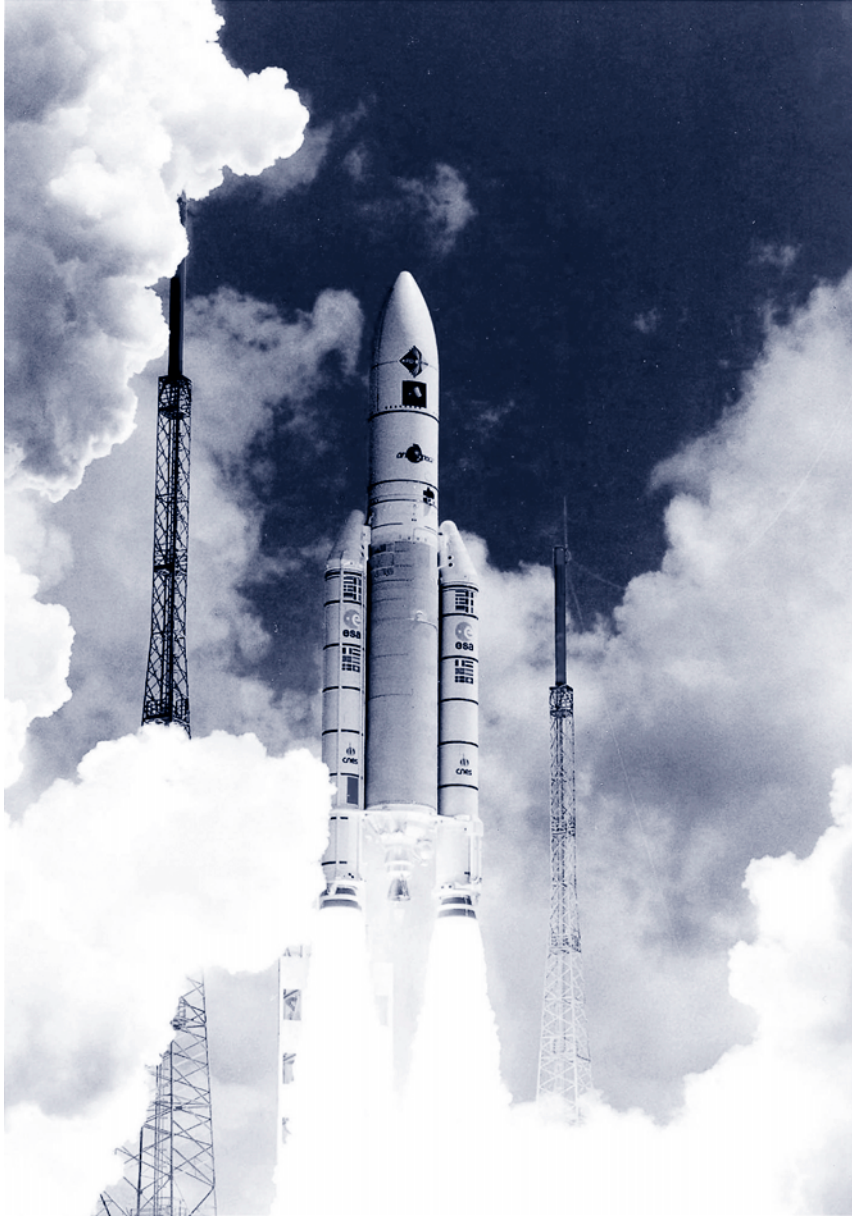
Most analysts and politicians have reacted to this situation with a renewed call for investment in space and for additional trans-Atlantic coordination of that investment. For example, some European governments were embarrassed by their inability to participate at the highest technical level in the 1999 Kosovo war, and some American leaders demanded additional European high-tech military spending to share the burden of alliance activity.⁶ Whether or not the calls for expansion of national security space budgets are heeded, the prospect of coalition military action suggests that decisions about national security space investment should be considered in the context of trans-Atlantic alliance relations.

Governments also face pressure from their domestic space industries to increase their military space budgets. Some of this pressure comes from the normal lobbying process: if firms can convince governments to buy additional systems from them, they can enjoy additional profits that will not be competed away; the profits would be protected by economies of scale and the value of firms' privately held intellectual property. On both sides of the Atlantic, however, this lobbying has been intensified in the space business by the collapse of commercial satellite sales (and therefore the collapse of demand for commercial space launch activity, too).⁷ The space-industry prime contractors are losing a great deal of money as they cut prices and desperately try to recoup some of the cost of the fixed investment in system development and production

capacity that they made in the expansive 1990s. Prospects for increased military space sales come at a particularly welcome time for the space industry.⁸

Governments hope that trans-Atlantic cooperation on military space projects will extend to the defense industry – and that private coordination will help solve the industry's overcapacity problem. If industry rationalization can reduce the capacity overhang, it will reduce the total costs of future space systems acquisition, which will help mitigate the effect of space-oriented spending on national budgets – an especially important concern in many European countries. Moreover, trans-Atlantic coordination among government buyers of space systems might reduce the risk of future overcapacity, at least on the military side of the business, if coordination helps to eliminate redundancy among programs. For now, though, existing industry overcapacity is yet another reason to believe that governments are likely to increase their purchases of space systems in the near future, and it is also another reason to consider the trans-Atlantic relationship to be an essential component of space policy discussions.

Defense investment plans on both sides of the Atlantic already reflect the early stages of increasing spending on space. The Congressionally-mandated Rumsfeld Commission, which reported in 2001, estimated that the United States plans to spend \$60 billion this decade to replace virtually its entire satellite inventory.⁹ Many existing satellite constellations are simply nearing the end of their operating lives, so military space investment is due for an increase. Meanwhile, European leaders have announced that they will channel their defense investment into four key capabilities, two of which emphasize



*Ariane V
rocket launch*

space systems (intelligence, particularly imaging and signals intelligence, and command and control, particularly communications satellites and ground stations).¹⁰ Specific plans for spending levels and detailed technical definitions of space systems are still evolving in both Europe and the United States.

Major national security investments, including investment in military space

applications, require the convergence of four key factors: technical capabilities, military operational requirements, domestic and sometimes international political support, and adequate economic resources. The remainder of this report considers prospects for national security space on both sides of the Atlantic, paying particular attention to a possible role for trans-Atlantic cooperation. The next section briefly describes the current American and European space systems and the next round of acquisition plans. The following section assesses recent trends in technology, military doctrine, political support, and economic factors in the space sector. The report concludes with discussion of key choices for policy-makers in the United States and in Europe that will determine the trajectory of the military use of space for the foreseeable future. This list

of choices should help focus discussions of space policy, separating core issues from less important concerns that clutter current debates. It suggests a possible way forward for trans-Atlantic cooperation in national security space programs, but no one should rely on trans-Atlantic cooperation alone to drive the space policy agenda or budget.

The Landscape of Space Systems

Through most of the Cold War, European governments did not emphasize investment in military space systems. Their American ally took care of that part of the military competition with the Soviet Union. In recent years, it has become a truism that Europe's lower level of military space capability limits its ability to participate in post-Cold War alliance endeavors. However, European governments have launched a number of satellites during the past several years, and a number of on-going programs will soon add still more European space assets.¹¹ The primary source of the gap in space capabilities is not a lack of technical competence on the Europeans' part; instead, the gap reflects an historical European choice to invest fewer resources in space and especially in military space projects.

With the United States continuing to buy advanced space systems, even the most ambitious European plans will not yield capabilities across the board equivalent to the American ones. European governments have not tried to duplicate the full range of American space assets. For example, no European countries are developing operational satellites for signals or electronic intelligence gathering, although France has a small SIGINT technology demonstrator program called ESSAIM scheduled for launch in 2004. The United States, meanwhile, has myriad

SIGINT and ELINT programs that build on an enormous foundation of Cold War investment. Even in project areas that address directly comparable missions, European plans do not call for the acquisition of as many satellites of each type as populate the American constellations, meaning that European systems' overflight coverage and revisit rates will not match their American counterparts.

Nevertheless, on-going European programs, if completed, will add substantially to European space assets. The result should be an absolute level of capability that will permit the kinds of military activities called for by European operational concepts. The burgeoning space capability may even permit the kinds of activities required for trans-Atlantic coalition operations. Nevertheless, "direct" interoperability may still be blocked by the use of different operational concepts by various alliance partners, inconsistent standard operating procedures for data gathering and dissemination, and incompatible technical standards for storing, processing, and communicating information. For example, the future French protected communications system, Syracuse III, will use Super High Frequency transmissions, while the American Milstar 2 and Advanced EHF systems are based on Extremely High Frequency transmissions. One could imagine forces

from both countries deploying to a coalition operation with a relay device to translate between the two protocols, allowing the units to communicate, but such a system would surely add complexity, introduce delays, and increase the cost of the coalition operation. An Interoperability Working Group of French and American specialists has been meeting to reduce the incompatibilities between the two systems, but its progress has been limited to the possibility that later satellites in the Syracuse III series will be equipped with expanded EHF capacity layered on top of their core protected SHF signal designed to the European standard. As a perhaps more likely and more successful alternative to direct interoperability, coalition partners might find it easier to arrange a division of tasks, with both countries contributing capable forces to the operation — each supported by its own space systems.

Table 1 lists basic information on the principal military space assets of the United States and of the major European countries, broken down by major category of space systems: intelligence gathering satellites (in this case, optical and radar imaging), communications satellites, navigational aid satellites, and launchers. These categories cover the major purposes for which space systems have been and will continue to be used in the foreseeable future.

The table is limited in two important ways. First, it only addresses classes of assets for which the Europeans have any capability at all, meaning that American SIGINT and ELINT satellites, surveillance, warning, and tracking satellites, military meteorological satellites, and other systems are not included.¹² Second, the table only shows satellite systems

whose primary tasking is military, meaning that a number of dual-use European systems are left off (the launch vehicles are listed even though military satellites do not constitute a majority of their payloads). For example, the French military will be allowed to use the high-resolution optical imaging capabilities of the Franco-Italian Pléiades constellation of scientific, civil security satellites. Because of the European emphasis on commercial and government space activities outside the military sphere, European militaries often make arrangements to share some percentage of the tasking time of primarily non-military platforms — just to get some space-based capability. European military demand for space assets is significantly lower than comparable American demand. By allowing governments to avoid the high fixed cost of acquiring what would be under-used, military-unique platforms, the dual-use satellites probably are an efficient solution in Europe.

On the other hand, it is reasonable to minimize the discussion of dual-use satellites in this report, because dedicated satellites are likely to dominate military transformation investment. Recent experience shows that the rapid rise in demand for satellite imagery has led the U.S. military to buy from dual-use sources like SPOT—a limited form of trans-Atlantic military cooperation. Such purchases are likely to continue, but dual-use systems cannot be optimized for real-time, high-volume, protected military space operations using complex battle management software. Those high-end specialized tasks form the core of the American military transformation vision. Moreover, the American military fears unauthorized information dissemination so much that it tightly restricts military-to-military

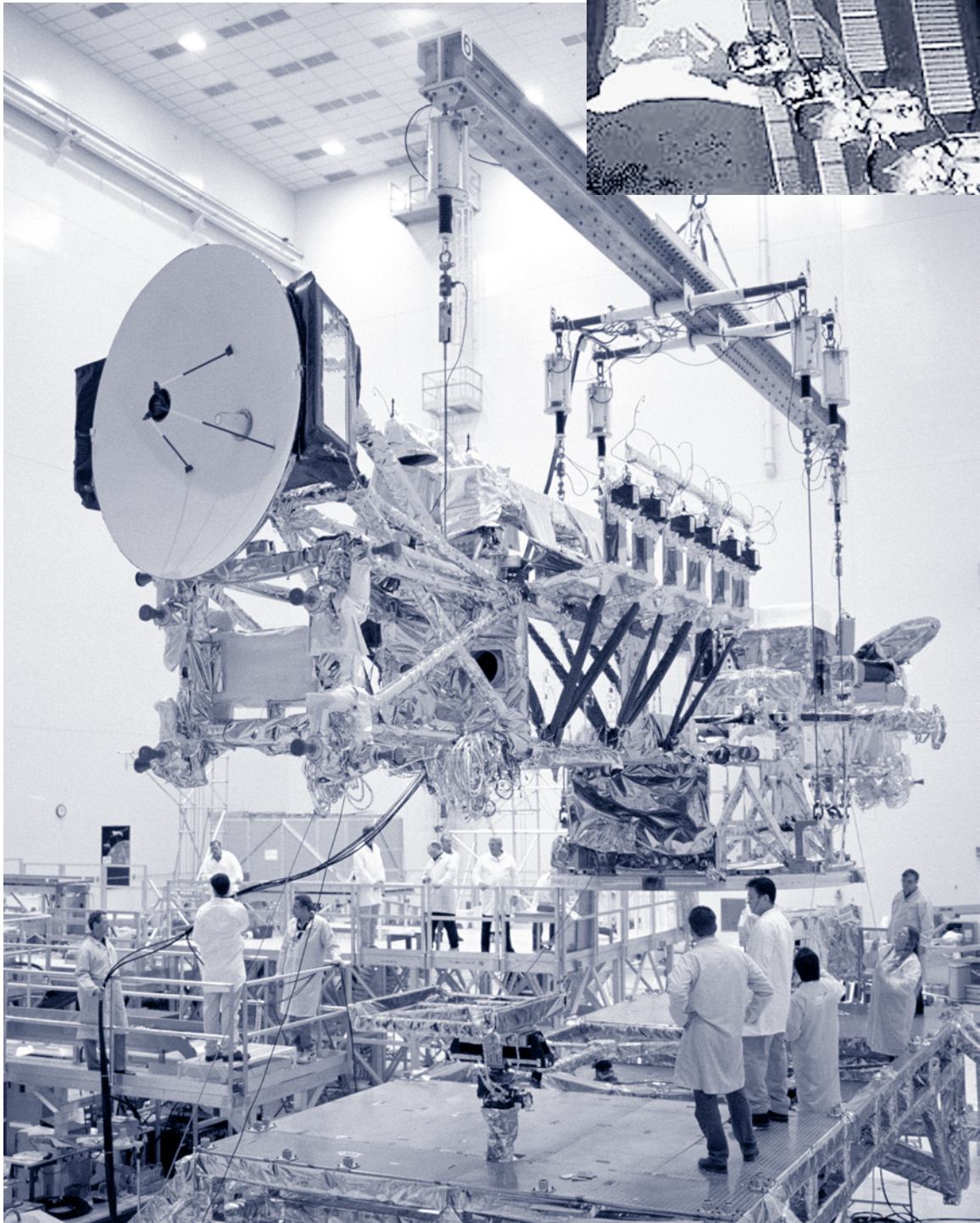
contacts and cooperation in the use of space with its close European allies. Those fears would be compounded in the case of trans-Atlantic cooperation on dual-use systems that inherently involve both foreign countries' militaries and their civilian bureaucracies. From the American perspective, European dual-use satellites have greater potential for trans-Atlantic scientific and perhaps civil security tasks—tasks on which American military does not take the lead in U.S. policy implementation.

The substantial increase in the quantity and quality of European space assets called for by current investment plans will augment the total amount of military-related capability orbiting the earth. However, that rise in global capacity is not likely to keep up with rapidly expanding demand for the output of military space platforms, whether the platforms are supporting an autonomous European operation, an autonomous American operation, or a coalition

| | U.S. | | EUROPE | |
|-----------------|---------------------|---------------------------------|----------------------|--------------------------------------------------------|
| | Current Generation | Next Generation | Current Generation | Next Generation |
| Optical Imaging | Advanced KH-11 | Future Imaging Architecture | Helios 1 (France) | Helios 2 (France, 2004) |
| Radar Imaging | Lacrosse | Space-Based Radar (2010) | None | Cosmo-Skymed (Italy, 2005) SAR-Lupe (Germany, 2005) |
| Communications | UHF Follow-on | MUOS (2007) | Syracuse II (France) | Syracuse III (France, 2003) |
| | DSCS | Advanced Wideband System (2009) | Skynet 4 (UK) | Skynet 5 (UK, 2005) |
| | Milstar 2 | Advanced EHF (2006) | SICRAL (Italy) | |
| Navigation | GPS | GPS III (2010) | None | Galileo (2008) |
| Launch | Atlas V Delta IV | | Ariane 5 | |

Table 1. Current and Planned Military Space Systems

Note: Countries listed in parenthesis after the names of European projects are the project leaders. Other European countries may participate with minority stakes in those projects. The years listed are the expected dates for the initial operational capability of each system.



Syracuse III (above)

Milstar 2 (below)

operation. The supply-demand imbalance will maintain pressure for additional space investment in the coming years, and it highlights the potential benefit of coordination in the allocation of scarce space resources during military operations. Any operation supported autonomously by European forces will face difficult negotiations over tasking the limited space assets available to European militaries, even presuming the smooth implementation of agreements on simple interoperability concerns and the operational dissemination of information. The recent document on Common Operational Requirements for a European Global System of Observation (Besoins Operationnels Communs) will present an important test.¹³ Similar trans-Atlantic cooperation could be even more operationally useful, different orbital tracks, which offer the potential for complementary coverage of different geographical regions, if their orbits were suitably planned. The opportunity cost of redundant or poorly coordinated capabilities will be especially large, if it turns out that many future military operations are implemented by coalitions supported by both European and American governments. Existing plans for the next generation of space assets do not reflect much trans-Atlantic coordination.



source: U.S. Air Force

*A time exposure of eight Peacekeeper (LGM-118A)
intercontinental ballistic missile reentry vehicles passing
through clouds during a flight test.*

Trends

National security space investment on both sides of the Atlantic is influenced by technological opportunities, changes in the way the military expects to operate, international and domestic political pressures, and the availability of economic resources to pay the unavoidably high acquisition costs for space assets. These trends overlap, and their effects interact, so categorization of different factors in military space policy is necessarily somewhat loose.

Technology

The key technological change affecting national security space is the rapid increase in computer processing power, which allows smaller platforms to handle more data in more sophisticated ways at higher speed than ever before. The information revolution has changed the military's demand for information, just as it has changed the pattern of demand in many sectors of modern society, and that new pattern of demand will spur investment in space-based assets. Innovation in computing also has direct effects on the supply-side of space systems.

The biggest effect of increasing computer power on the space sector is in the area of intelligence gathering. The deployment of more and more satellites sensing more and more types of information is overwhelming the ability to analyze the data that they return. Faster processors

can help to catch up, increasing the timeliness, and therefore the value, of the information that sensors provide. Furthermore, the availability of small, lightweight ground stations or computers embedded in other military systems may in the future decentralize the processing task, allowing the ultimate users of the data more control over when and in what ways data are analyzed.

Most important, however, in terms of directly improving space-based surveillance, faster computers can derive extra information from sensing data, yielding improved resolution, higher signal to noise ratios, and more specific descriptors of imaged scenes. Traditionally, one key job of human intelligence analysts has been to compare data from different sources and different types of sensors, slowly piecing together a complete picture; such data fusion is an essential way to overcome adversaries' camouflage and deception efforts. Both software and hardware solutions are getting better and better at automating at least part of that task, one form of "hyper-spectral sensing."¹⁴ Moreover, new types of signal processing are becoming feasible for general-purpose use, allowing collection of additional information from the same dataset — as in the use of synthetic aperture radar to gain both accurate position information and to measure movement within the scene through interferometry.¹⁵ The new

information products may provide the crucial underpinnings of the “Common Operational Picture” that is a vital element of the American military’s transformation plans. They may also help achieve military planners’ goal of “one shot, one kill” strikes with precision ordinance that proved so elusive in the Kosovo air campaign in the face of Serbian forces’ mobility and effective use of decoys.¹⁶

Technological improvements, especially in processing power, also have implications for communication and navigational aid satellites. Military communications networks are being flooded with demand to transmit information as commanders use every technique at their disposal to try to minimize the impact of the “fog of war.” Faster application of data compression algorithms, allowing real-time transmission of voice and especially video images, can help mitigate bandwidth constraints. Small, low-cost signal processing equipment may be added to GPS receivers so that they can continue to function despite glitches in their reception caused by interference or jamming attempts.¹⁷ But these incremental improvements in the use of space-based assets, although potentially important, are likely to be less significant than the computing-induced innovations in remote sensing that are beginning to provide entirely new types of information.

As tantalizing as the advances in information gathering and dissemination are, some important constraints are not likely to be overcome in the near term. Consequently, the full vision of a space-based information technology revolution in military affairs will not arrive imminently.¹⁸ In the area of earth surveillance from space, for example, delays can be introduced into the process at any of seven

major stages: tasking the satellite, accessing the area of interest, transmitting the raw data through the satellite downlink, processing, interpreting the resulting information, disseminating the results, and applying the information through command and control of operational forces. Many of these stages require human intervention (especially choosing the task and applying the results), and the threat of delay even at the other stages will not principally be solved through technological fixes. Instead, the key step will be to invest more resources to increase the number of imaging and communications satellites, ground stations, and analysis centers.

Military Operations

More intensive use of space systems, especially space-based communications systems, certainly has the potential to transform military operations. However, the particular effect on military doctrine of tighter links to front-line forces is not foreordained. The differences between the American and European militaries’ visions of future operations are likely to lead to different levels and types of investment in national security space systems. Those differences raise barriers to trans-Atlantic co-development of new space assets, and they also suggest limits to the direct interoperability of trans-Atlantic coalition forces. If the American and European militaries truly expect to deploy forces in different sorts of contingencies and to fight in different ways, it is hardly surprising that their procurement agencies are inclined to buy different military space products.

The predominant transformation vision in the United States calls for pushing decision-making down to the small-unit level. The idea is that

decentralized units will be able to make decisions to apply certain tactics, techniques, and procedures according to an overall military doctrine; if the various units base their decisions on the same core information that is shared through a communications network, then coordination of friendly forces should emerge naturally.¹⁹ Advocates of this vision believe that a higher-echelon commander would not be able to achieve the same level of coordination using a hierarchical management scheme, because modern military operations involve too many complex, high-speed interactions.



Military Communicator vans

To implement this transformation vision, the U.S. military expects to develop a high-bandwidth, secure communications infrastructure that will disseminate information widely. Various acquisition projects have been started to develop tools that small units can use to query and update an overall database of information about the battlespace. Ideally, such decentralized querying across the two-way network will allow units to use their knowledge of their local situation to ask for the right information support from the wider information network. Unfortunately, the broad acquisition program will require the United States to spend a great deal of

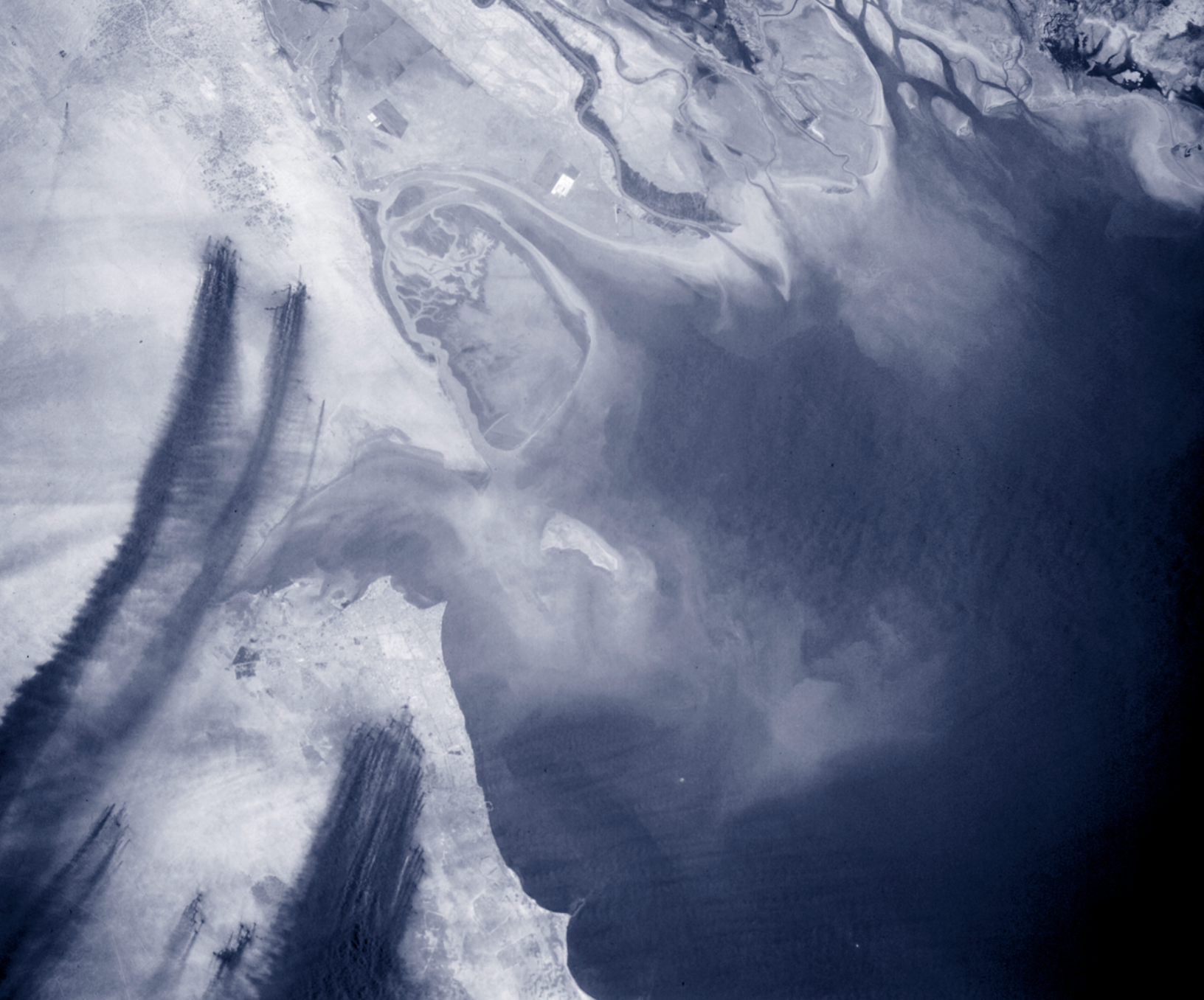
money distributing communications terminals and display equipment throughout its forces.

On the other hand, European governments and militaries seem inclined to use their communications infrastructure to enhance the view of the battlespace available to higher-level officers or even political authorities. In general, they have been less impressed by speculation about the information revolution in military affairs and less

attracted to analogies between military leadership and management reform at American companies.²⁰

Although European leaders recognize the same complexity

in modern military operations that drives decentralization in the American visions, their reaction to it tends to be different. It may be very difficult to specify appropriate tactics, techniques, and procedures and military doctrine for all possible contingencies, especially when the rules are expected to be applied under highly complex, uncertain, and perhaps unforeseeable conditions.²¹ Many military operations now take place in highly politicized environments, especially in the increasingly common “Operations Other than War” such as humanitarian interventions and peace-keeping operations.²² Political leaders may be best prepared to deal with potential diplomatic and political repercussions of



*Kuwait oil field fires
during the Gulf War*

policy and operational choices; the electorate specifically entrusts them with the power to trade off risks and benefits and to make value judgments. The military advantages of delegating decisions to expert professional soldiers should be balanced against the advantages of maintaining political control of deployed forces.

If future command, control, and communications equipment requirements — including requirements for space assets

— are intended to facilitate hierarchical control by top political or military leaders, they need not be designed for as much two-way, high-bandwidth transmission capacity as they would need in the more decentralized vision. Furthermore, fewer expensive terminals and displays need to be procured, because the most sophisticated kits need not be distributed to every small unit.

The divergent views of likely military operations have similarly divergent

implications for imaging and navigational aid satellites. American transformation advocates hope that future military forces will be able to use better real-time intelligence combined with robust, reliable, and precise positioning data to emphasize maneuver rather than mass in military action. Smaller, more agile and better-informed forces will launch precision strikes from stand-off range and then move away using satellite navigation before enemy forces have time to react – avoiding the need to protect friendly forces with armor, which slows them down and makes them difficult to transport to distant theaters of operations. Consistent with this emphasis on maneuver, future space systems may be designed to minimize the logistical burden that terrestrial C³I equipment currently imposes on deployments.²³ Finally, the emphasis on maneuver and the goal of minimizing the number of assets deployed also suggests reliance on surveillance satellites rather than terrestrial reconnaissance platforms (manned aircraft or UAVs), because the latter require in-theater bases for their operations. In sum, major investment in all types of space systems is an integral part of many American advocates' transformation visions.

Current plans for European military space investment do not emphasize maneuver of military forces in the same way; instead, European plans are linked to civil security operations in response to humanitarian crises and to peacekeeping operations – missions that are tied to specific geographic areas. Peacekeeping operations require particularly sedentary force deployments, for example to staff checkpoints and patrol borders. In fact, persistence rather than maneuver makes an important contribution to military effec-

tiveness in peacekeeping. In humanitarian missions, space observation can contribute to damage assessment and mapping of humanitarian disasters, enforcement of territorial settlements and environmental agreements, and monitoring of cross-border criminal activity. Some of these tasks truly require the space-based vantage point, but others can be completed by UAVs and other terrestrial assets. If this view of future military operations is right, then much less space-related infrastructure investment will be necessary.

Politics

The most important trend in international politics affecting trans-Atlantic plans for the military use of space is the new prevalence of coalition operations.²⁴ Throughout the Cold War, the NATO alliance struggled to prepare for an enormous, closely integrated coalition operation: the defense of Europe against a threatened Soviet invasion. Alliance defense planning led to a never-ending and always-incomplete quest for coordinated trans-Atlantic investment in interoperable forces. Yet European coalition forces accompanied relatively few operational deployments of American forces during the Cold War, giving the impression that the American military acted relatively alone during that period. In the 1990s, on the other hand, American and European troops frequently deployed side by side to crisis areas, and the conventional wisdom now calls for multilateral support as a prerequisite for military action.

Humanitarian operations tend to attract coalition support, because the situations that precipitate them are universally condemned — for example, essentially everyone is in favor of alleviating suffering from earthquake or hurricane

damage. Moreover, many militaries are prepared to participate in UN-endorsed peacekeeping forces designed to end civil conflicts, because they are relatively unlikely to face high-intensity conventional attacks in those missions. Great powers have also been sensitive to the benefits of UN support for peacekeeping efforts that might otherwise be criticized as neo-imperialist. Even controversy about “major theater wars” can be partially defused by building international coalitions, as witnessed in the 1991 Gulf War.

A strong political commitment to trans-Atlantic military cooperation could either increase or decrease total spending on space. The expectation that militaries will need to work together in coalitions during future operations may bring about a “harmonization up” of requirements for investment in space. In order to deploy with American forces that intensively use space systems, European militaries would need to accept certain technical standards to “plug in” to the American network, so that American and European forces could identify each other as “friends” on the information grid, so they could benefit from access to the same intelligence, and so they could both contribute to the constant updating of the Common Operational Picture. This harmonization of systems requirements would also require a substantial shift in European resources towards space systems and, specifically, towards military rather than civil space systems.

Alternatively, the prospect of acting through coalitions may limit the ability of the United States to integrate space-based assets into routine military operations as fully as it would like, because of European reluctance to match the investment levels and to implement the doctrinal changes

that follow from the intensive exploitation of space assets. It would certainly be costly for the American military to preserve centralized information processing and distribution channels for working with allies while decentralizing its own forces and buying new, network-centric systems to support them. It might even prove impossible for the American military’s organizational cultures to encompass simultaneously both hierarchical and decentralized attitudes towards information. As a result, if the American commitment to coalition operations were strong enough, one might imagine that that commitment could actually hinder American plans for a space-intensive transformation, reducing the total amount of spending on space.

A third possibility is that the preference for different levels of integration of space systems into military operations may prove stronger than the interest in coalition operations. The alliance partners may simply choose different paths to provide security for themselves. That divergence could be reflected in political acrimony over the space budget, with the United States pressuring its European partners to increase spending and to change military doctrine. On the other hand, such a divergence need not split the political commitment of NATO members to defend each other: it might only reduce the frequency of side-by-side coalition operations. The preference for different investment trajectories could be reflected in coalition operations where the partners provide political but not military support – as, for example, was largely the case in the 1991 Gulf War, where very few of the allies in the grand coalition arrayed against Iraq engaged in serious fighting.²⁵ One could also imagine an amiable agreement

for forces within the alliance to specialize, especially if the highly space-intensive American doctrine is better suited to high-intensity combat operations, while the less space-intensive European doctrine is better suited to post-conflict reconstruction and peacekeeping.

Despite the recent European announcement that they intend to specialize in certain niche capabilities within their Defense Capabilities Initiative, the historical experience with intra-NATO specialization does not suggest that a formal trans-Atlantic division of labor is very likely. Furthermore, the specific capabilities on which the Europeans have chosen to focus their investment – strategic airlift, intelligence, command and control, and anti-terrorism – seem to suggest an intent to “keep up” as best they can with the American transformation program rather than to specialize in different kinds of military

operations. Even with the promise to focus their investment in certain key niches, many American analysts still worry that total European spending will not be sufficient to enable close coordination of coalition operations; others are more optimistic on this point.²⁶

The projects on which Europe is spending its relatively scarce

space resources might indicate a lot about European governments’ beliefs about the future of trans-Atlantic cooperation in the military use of space. The European choice to build the Galileo navigational aid satellite constellation is a good example of the competing influences on space policy decision-making. Even if European investment in Galileo does not strictly duplicate the American investment in GPS (and some would argue that it does), it is surely the case that resources devoted to Galileo are not being spent for the greatest marginal gain in total trans-Atlantic coalition space capabilities.²⁷ If Europe’s true interest is to improve navigational aid service quality by making more satellites visible to each receiver or by speeding the transition to satellites that broadcast a high-power signal that is less vulnerable to interference and jamming, then Europe could most efficiently serve that goal by



helping to pay for additional GPS III satellites rather than by building a competing system. On the other hand, Galileo provides a very large marginal benefit to European military users if they anticipate the possibility of a future operation that American decision-makers will not only choose not to join but will actively oppose enough to deny the GPS signal to the European forces. Despite histrionic political rhetoric in Europe about Galileo's essential contribution to Europe's sovereign autonomy, the probability that the United States would actively oppose a European military operation (rather than just passively declining to support it or pressing through diplomatic means for its cancellation) is vanishingly small. So European investment in Galileo makes little sense if the program is intended either to demonstrate commitment to trans-Atlantic coalition operations or to provide a necessary escape from over-dependence on American space assets.

Instead, the most likely reason for the choice to buy the navigational aid system rather than to commit the same European resources to another military-related space project (e.g., additional intelligence or communications satellites) is that Galileo serves domestic political economy interests in Europe. A second important political trend — in addition to the increasing frequency of coalition operations — is also affecting future investment in national security space: since the collapse of the Soviet Union, the direct military threat to NATO has plunged, leaving domestic politics as the most salient factor in decision-making on defense budgets.²⁸ In the face of pressure to cut budget deficits to meet the targets set for European monetary integration, and lacking strategic justifications to protect defense spending,

governments have resorted to creative strategies to find any resources at all for investment in military systems.²⁹ Like many other European space systems, Galileo has dual-use applications to both military and commercial operations. The European governments hope that commercial users will pay most of the bill for the system after the governments' initial expenditures for development of the first satellites. Other types of military space systems offer considerably less short-term opportunity for such domestic cost shifting: the demand for commercial communications satellites has collapsed, and the market for commercial high-resolution satellite imagery has developed very slowly. Under those circumstances, although Galileo will not contribute as much marginal military capability to trans-Atlantic coalition operations as an alternative European space program might, it may be the biggest feasible contribution in the face of European domestic political concerns. Trends in international coalition politics and in domestic budgetary politics combine to affect actual spending on national security space.

Economics

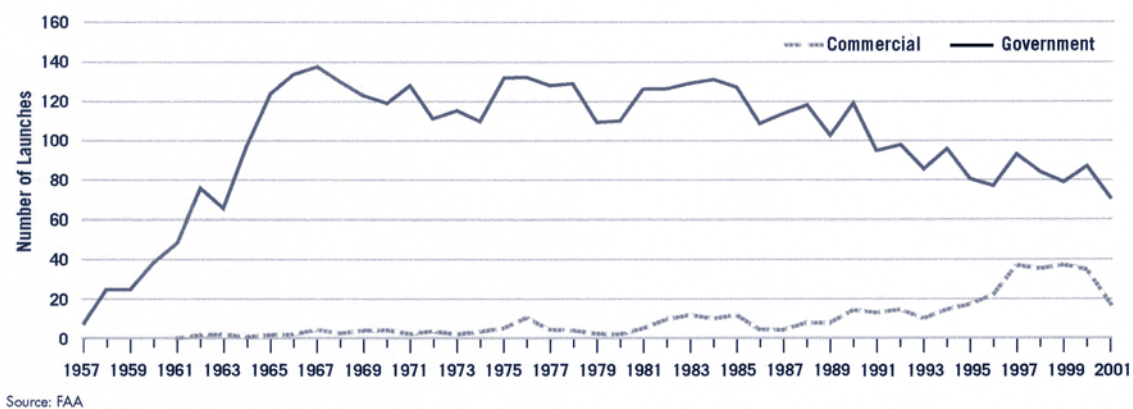
In the 1990s, the space industry responded to predictions of endlessly growing demand for commercial telecommunications with a burst of investment in production capacity for both space launch and satellites. Several major projects for global mobile telephony later declared bankruptcy, while other systems were drastically scaled back. Meanwhile, domestic and international terrestrial telecommunications networks were also over-built using new fiber optic technologies. Demand did not grow as fast as telecommunications service providers had hoped, and few firms

ever developed business models that could earn a profit in the telecommunications sector. Many service providers have declared bankruptcy, the vast majority of installed cable today is not even turned on, and no one is investing in telecommunications equipment. The trickle down effect on the market for satellites and space

equity to maintain investors' willingness to continue operations. At some point, the company's remaining assets are liquidated so that investors can cut their losses, but it is the investors who nevertheless pay the sunk cost.

In the space industry, political and strategic factors enter into the calculus in

American Commercial and Government Launches (1957-2001)



launches has devastated the space industry, because its 1990s investment in production capacity is earning almost no sales revenue. The primary economic issue that remains to be settled now is who is going to pay the bill for the sunk cost of that investment.

In most industries, shareholders and bondholders bear the cost of over-investment. Companies borrow money to finance capital investment, or they accept a temporarily low rate of return as earnings are retained to pay for production capacity that is expected to generate higher returns in the future. If those high returns do not materialize, then the firms will be unable to pay back the money that they borrowed or to provide a sufficient rate of return on

ways that do not apply to most other sectors. Because governments buy space products from the same firms that bet on optimistic commercial market projections, the companies can try to pass the cost of overcapacity on to governments through two different mechanisms. First, firms can induce governments to expand their demand by lobbying: commercial buyers only respond to economic incentives, but politicians also respond to the threat of layoffs and high-visibility plant closings. They are often willing to spend public money to preserve their own re-election prospects by keeping defense-oriented firms afloat. Second, governments buy military space assets according to their national military strategies, and they often

fear that liquidation of a prime contractor might leave them unable to acquire a vital military system in the future. Consequently, governments are willing to buy an option on space companies' future production possibilities, essentially paying to keep them in business despite their past failed investments. Arguably, commercial customers should be willing to pay something for a similar option on commercial capacity, but it seems reasonable to believe that the national security option value is higher. As a result of these two factors, overcapacity in the space industry tends to persist, and it tends to be costly in terms of the productivity of national security space spending. The current acute overcapacity crisis could significantly raise the cost of "transformational" space investment – perhaps to a prohibitive level, especially for European countries.

As is often the case, governments and firms are searching for creative ways to pass the cost of the sunk capital investment to someone else. That search has spurred interest in trans-Atlantic restructuring of the space industry, because mergers and acquisitions are often accompanied by consolidation of production capacity. However, there is still no such thing as a free lunch. Either the buyer or the seller must pay the sunk cost. The buyer pays by capitalizing the cost in its offer price even though it does not expect a return on that investment, or the seller pays by accepting a bid that does not include reimbursement of its wasted investment expenses. Because both parties come to trans-Atlantic merger discussions with cost shifting as a key part of their negotiating agenda, it is unlikely that any major deals will actually be consummated.

The need to resolve the overcapacity crisis in the space industry has another important economic effect on prospects for national security space policy. The efficient way to pay the sunk cost bill is to produce more copies of existing systems. Militaries should expand the constellations of current satellite designs rather than developing additional types of satellites or modernizing the major space tasks with all-new designs. Plans that require additional research and development expenditures and capital



Soldiers set up a mobile satellite communications link.

investment in updated production facilities would simply add to the total capacity overhang that has to be paid for. On the other hand, buying current generation designs would garner some strategic benefits by reducing delays between overflight times for intelligence satellites, increasing the quality of coverage for navigational aid satellites, and expanding the bandwidth available for military communications. Developing new satellite and space launcher designs is the expensive way to proceed, so economic trends suggest that transformation advocates and others who want to invest in space systems innovation need to pass a higher bar in their policy analyses than simply showing that new designs offer military advantages compared to the existing state of the art.



Athena
rocket
launch

Choices for National Security Space Policy

Trends in technology, military operations, politics, and economics suggest several possible future trajectories for national security space policy, depending on decision-makers' choices about military doctrine, the level of investment, and the political goals that leaders hope to achieve using military operations that rely on space assets. The key decisions depend on the answers to five questions.

When Is Technological Improvement “Enough?”

Over the past several decades, computer performance has improved very rapidly – with processing speed roughly doubling every eighteen months, according to “Moore’s Law.” As a result, the technology available today to build space systems is far more sophisticated than the technology that was available when the previous generation of satellites was designed. But even if Moore’s Law is not literally true or if it applies less well in the future than it has in the past, we can expect that the frontier of space systems technology will be even more advanced if we wait a few years to lock in our space platform designs rather than buying the best platforms that we can currently build. Military doctrine and equipment requirements should evolve together over time. Military doctrine is currently changing very rapidly as theorists speculate about the effects of

transformation, so it seems a particularly inopportune time to sink resources into deployment of space systems. On the other hand, it is very difficult to obtain experimental evidence to evaluate doctrinal changes without building some new systems. That conflict presents policy-makers with the question, “when is it time to move acquisition programs out of the research and development phases and into production?”

The American military has responded to this technological uncertainty by initiating a new, iterative acquisition process, spiral development, in which the services buy weapons in stages. The first few deliveries will not meet all of the long-term system requirements, but lessons learned during the production process and during the initial operational use of the new system can be applied to later deliveries; the initial, more experimental versions can be upgraded to the final configuration later. Unfortunately, spiral development is difficult to apply to space-based platforms, because once a satellite is launched, its configuration cannot be adjusted. Furthermore, the total population of each kind of satellite is small enough that deployment of any satellites with limited capabilities could impose major constraints on the performance of the overall constellation. These factors make the “When is technological improvement enough?” question

particularly acute in national security space policy.

How Much Capability Is “Enough?”

Many opportunities to increase the military value of space assets can be addressed by expanding the population of satellites rather than by waiting for technological advances. Specifically, revisit rates for imaging satellite constellations, signal robustness for navigational aids, and bandwidth adequacy for communications networks all depend on line-of-sight contact between satellites and points on the ground. Improvements in power generation, antenna sensitivity, signal processing, and other technical features of satellites may improve visibility within a satellite’s viewing horizon – for example, improving the resolution of images taken with off-nadir scanning – but no improvements can overcome the physical barrier that the horizon poses. The direct solution is to buy more satellites, making the core policy issue the size of the space acquisition budget.

It is especially difficult to establish rational budgets and system specifications in a strategic environment without a peer competitor. In traditional threat-based planning, the need to counter specific adversaries’ capabilities and intentions sets clear performance requirements for acquisition programs. Today, however, the United States is trying to apply “capabilities-based planning” to ensure long-term strategic flexibility. But because leaders would prefer any enhanced capability to a less capable system, capabilities-based planning does not help much to prioritize investments.

If the defense budget were unconstrained, then there would be no cost to the inability to prioritize; if, on the other hand,

total expenditure is capped, as it surely is in European countries, then spending on any particular program imposes a substantial opportunity cost in terms of foregoing the acquisition of other military systems. Spending on space notably comes at the expense of terrestrial systems, including systems like high-altitude unmanned aerial vehicles that might perform military tasks comparable to those assigned to satellites. In most countries, the organizations that oversee acquisition of space systems are not the same as those that oversee terrestrial military procurement, so it is difficult to make sensible trade-offs between the two kinds of investments. The trend in acquisition reform, especially in the United States, is actually to separate space systems into their own category, protected by a strong organizational advocate (e.g., the Undersecretary of the Air Force) who has little incentive to consider the full opportunity cost of spending on space.

How Much Are Military Forces Expected to Fight?

Different military missions call for support from different kinds of space assets and for using those assets in different ways. The intensive use of space systems envisioned in American concepts of military transformation is primarily intended to cause a quantum increase in military effectiveness in high-intensity combat—using “information dominance” to destroy more enemy units, faster, while exposing as few friendly forces as possible to hostile fire and minimizing collateral damage. If militaries will frequently engage in high-intensity combat in the future, then the more expensive version of space investment that pushes direct access to space down to the small unit level should pay off. On the other hand, if the main tasks for militaries

in the future are humanitarian interventions and peacekeeping operations, then a more limited approach to space investment might make more sense. European militaries tend to advocate this trajectory for space acquisition.

Neither investment plan will “better” improve military effectiveness; instead, each one serves a different strategic goal. If American leaders buy a “European” space capability while maintaining a grand strategy that stresses high-intensity conflict, their forces will be plagued by “political-military disintegration,” a situation that historically has often led to military disasters.³⁰ Similarly, if European leaders buy an “American” space capability while maintaining a grand strategy that emphasizes operations other than war, their forces will likewise fall victim to political-military disintegration. The cost of over-emphasizing space assets in that case might be borne by the military in terms of inadequate investment in training or other types of equipment; alternatively, the cost of that political-military disintegration might fall on the rest of society, as the defense budget consumes too much of national wealth. To avoid those undesirable outcomes, political leaders in both the United States and in Europe should consider their space investment decisions explicitly in the context of national grand strategies.

How Decentralized Should Control Over Military Operations Be?

American and European leaders value both military effectiveness and political control of military operations, but they tend to assign different relative importance to the two goals. The conventional wisdom not unreasonably holds that American political



*Carriers are now
connected globally*

ideals emphasize individualism, while European ideals give pride of place to group interests and social welfare. It should not be surprising that those different values can be reflected in decisions about military doctrine. Sometimes, cutting-edge technologies will advance both military effectiveness and political control at the same time, but at other times – including, apparently, the present – innovation may force a choice to emphasize one goal or the other. New space-based assets today could be used either to decentralize or to centralize control of military operations. That decision will change the specific requirements definitions for the next generation of space projects.

Some level of trade-off between political control and military effectiveness may be real, but decision-makers should also bear in mind that neither goal can be

perfectly achieved, regardless of the level of space technology. In the centralized vision, intensive communications can improve the decision-makers' picture of the local situation, allowing them to embed operational decisions in the broader perspective of statecraft. However, political leaders are unlikely to ever be able to learn enough information – specifically about the intentions of people in the objective area (are they “innocent” or are they combatants?) – to be certain that they are making the right choices.³¹ Decisions by politicians remote from the theater of operations are also unlikely to be made fast enough to keep up with events on the ground. Communications delays will rarely be the rate-limiting step in political decision-making; many delays will stem from back-and-forth political debates as broader access to information invites more interest groups into the decision-making process.

On the other hand, a military that provides decentralized access to information, allowing small-unit commanders the autonomy to make decisions informed by local conditions, is unlikely to be able to develop standard operating procedures to account for every possible contingency. As a result, apostles of transformation probably exaggerate the likelihood of “self-synchronized” military operations, in which coordination emerges because each independent unit is trained to act in a particular way in each possible contingency. In reality, there is no purely technological answer to the problems raised by the complexity, speed, and political gravity of events in modern military operations.

How Integrated Do Coalition Military Operations Need to Be?

Allocating different sectors of responsibility to troops from different countries or deploying them in sequence for different mission components of an overall operation should allow units with different equipment, doctrine, and training to cooperate in coalition operations. Moreover, the main benefit of coalitions may be political or diplomatic rather than military. Military and economic efficiencies do not always dictate policy and national leaders may believe that international cooperation is vital for gathering and maintaining public support for military action. In that case, direct inter-operability of maneuver units may be a less pressing need than it would be if allied forces were required to intermingle for combat operations.

Even if they are not all deployed with the intent of participating in high-intensity combat, forces from several countries that are not equipped for direct inter-operability can contribute substantially to the political-military effectiveness of the trans-Atlantic alliance. As a result, military planners and diplomats need not overcome the difficult obstacles to the full harmonization of tactics, techniques, and procedures—and the complete standardization of technologies like space systems that support military operations will also not be required.

The Future of Trans-Atlantic Cooperation in Military Space

The United States and Europe have generally compatible foreign policy interests that sometimes diverge in specific cases, and they have generally compatible approaches to defense acquisition that also sometimes diverge. Defense planning during the next decade is likely to involve increases in space budgets on both sides of the Atlantic. Although there would be certain efficiency gains to collaboration on national security space policy, the military use of space is not currently an area naturally prone to high levels of cooperation. If policy-makers decide that they place a high value on tight integration and inter-operability of coalition military operations, they will have to make certain decisions about budgets and military doctrine subservient to that goal – a substantial cost to weigh against the benefits of cooperation. It is more likely that policy-makers on both sides of the Atlantic will recognize the opportunities afforded by investment in the military use of space, and each country will independently pursue its own agenda in that area.

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20. Nicole Gnesotto, "Preface," in Burkard Schmitt, ed., *Between Cooperation and Competition: The Transatlantic Defence Market*, *Chaillot Paper* No. 44 (Paris: Institute for Security Studies, January, 2001), p. v.
21. A rather large literature has developed in economics on the pernicious effects of "incomplete contracting" under these circumstances. See, for example, Paul Milgrom and John Roberts, "Bargaining Costs, Influence Costs, and the Organization of Economic Activity," in James E. Alt and Kenneth A.

Shepsle, eds., *Perspectives on Positive Political Economy* (New York: Cambridge University Press, 1990), pp. 57-89.

22. Michael C. Desch, "Why MOUT Now?" in Michael C. Desch, ed., *Soldiers in Cities: Military Operations on Urban Terrain* (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, October, 2001), p. 3.

23. The current generation of C³ ground equipment needed by the "light" 10th Mountain Division fills approximately 100 loads of C-141 transport aircraft; transformation advocates hope that new systems could substantially reduce that burden.

24. The post-September 11, 2002, war on terrorism has increased the salience of non-traditional threats, a major geopolitical change, but it has not had much direct impact on national security space policy. On the offensive against terrorists, the U.S. military, with or without allies, may be deployed more often or in more parts of the world simultaneously than had been expected before September 11th. Such deployments would increase the demand for space systems without substantially changing the nature of the challenges or opportunities for the military use of space. Projected increases in spending on space discussed in the first section of this report are already adjusting to the initial operational experiences from Operation Enduring Freedom.

25. Daryl Press, "The Myth of Air Power in the Persian Gulf War and the Future of Warfare," *International Security*, Vol. 26, No. 2 (Fall, 2001), p.5.

26. Martin Agüera, "Spending Gap Bedevils NATO," *Defense News* (October 8-14, 2001), p. 1; Charles L. Barry, "Coordinating with NATO," in Hans Binnendijk, ed., *Transforming America's Military* (Washington, DC: National Defense University Press, 2002), pp. 247-54, 257.

27. Caroline Chaumont, "Europe to Compete with U.S. Global Positioning System," *Washington Post* (May 30, 2002), p. E4; Gerry Byrne, "Global Fix," *New Scientist*, Vol. 174 (May 4, 2002), p. 32.

28. Gholz and Sapolsky, "Restructuring the U.S. Defense Industry."

29. Despite intense pressure from its European partners, Germany in particular has failed to fund its part of several multinational acquisition plans on schedule. See Martin Agüera, "German Reform Needs Reform, Some Say," *Defense News* (July 22-28, 2002), p. 20; Martin Agüera, "Germany Puts European Programs in Doubt," *Defense News* (July 1-7, 2002), p. 6. Attempts to shift costs to international partners are likely to plague many collaborative acquisition programs. See Eugene Gholz, "The Irrelevance of International Defense Mergers," *Breakthroughs*, Vol. 9, No. 1 (Spring, 2000), p. 8. Budgetary constraints are much less important in U.S. defense procurement, especially since the 9/11 terrorist attacks. Harvey M. Sapolsky and Eugene

Gholz, "The Defense Industry's New Cycle," *Regulation*, Vol. 24, No. 3 (Winter, 2001-02), pp. 44-49.

30. Barry R. Posen, *The Sources of Military Doctrine: France, Britain, and Germany between the World Wars* (Ithaca, NY: Cornell University Press, 1984), esp. pp. 24-29; Jack Snyder, *The Ideology of the Offensive: Military Decision Making and the Disasters of 1914* (Ithaca, NY: Cornell University Press, 1984).

31. Consider the challenges faced by American soldiers in the chaos of Mogadishu. Mark Bowden, *Black Hawk Down* (New York: Atlantic Monthly Press, 1999).

Space and Security

Co-organized by the
MIT Security Studies Program
MIT France Program
The French Embassy

MIT Faculty Club
Cambridge, MA

Day 1: April 22

- 8:00-8:45 Registration and Continental Breakfast
- 8:45-9:00 Welcome and Opening Remarks,
Vincent Sabathier, French Embassy/CNES
Eugene Gholz, MIT
- 9:00-11:00 Panel I: Background on Technology
Chair: Eugene Gholz, MIT
- Space Surveillance
Grant Stokes, Lincoln Lab, MIT
- Earth Surveillance
Robert Preston, RAND
- Civil Security
Jose Achache, ESA
- 11:00-11:15 Coffee Break
- 11:15-12:15 Panel II: Current Operations
Chair: Harvey Sapolsky, MIT
- U.S.
BG Michael Hamel, Directorate of National Security Space Integration
U.S. Air Force Headquarters
- Europe
BG Daniel Gavoty, Space Office of the Etat Major des Armees
- 12:15-2:30 Lunch
- Introduction
Claude Canizares, MIT
- Keynote Speakers on European Vision
François Bujon de l'Estang, Ambassador of France
Dominique Klein, The Delegation of Strategic Affairs

- 2:30–4:15 **Panel III: Industry**
Chair: Daniel Hastings, MIT
- Blaise Jaeger, Alcatel Space
Gerald Lepeuple, SNECMA
Louis Laurent, Arianespace
Gilles Maquet, EADS
Jennifer Warren, Lockheed Martin
Steven Harrison, The Boeing Corporation
- 4:15–4:30 **Break**
- 16:30–18:00 **Panel IV: Experience with Trans-Atlantic Ties**
Chair: Vincent Sabathier, CNES
- Claude Canizares, MIT
BG François Fayard, Service des programmes d’observation, de
télécommunication et d’information
Scott Pace, U.S. OSTP, Space and Aeronautics
Serge Plattard, CNES
- 18:00–18:45 **Cocktails**
- 18:45–21:00 **Dinner**
Host : Harvey M. Sapolsky, MIT
- Keynote Speaker: Dr. James Roche, Secretary of the Air Force

Day 2: April 23

- 8:30–9:00 **Breakfast**
- 9:00–12:00 **Discussions**
Moderator: Eugene Gholz, MIT

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